United States Environmental Protection Agency
Consent Decree

Civil Action No. 12-3404 (ccc)

Engineering Flow Study

The City of Perth Amboy, New Jersey

June 2013

CDM Smith

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June 30, 2013

Chief, Environmental Enforcement Section
Environment and Natural Resources Division
U.S. Department of Justice
601 D Street N.W.
Box 7611 Ben Franklin Station
Washington,D.C.20044-7611
Re: DOJ No.90-5-2-1-09500

Chief, Water Compliance Branch
Division of Enforcement and Compliance Assistance
U.S. Environmental Protection Agency
Region 2
290 Broadway - 20thFloor
New York, NY 10007

Chief, Water and General Law Branch
Office of Regional Counsel
U.S. Environmental Protection Agency
Region 2
290 Broadway - 16th Floor
New York, NY 10007

Subject: United States of America v. The City of Perth Amboy, New Jersey
DoJ Ref: 90-5-2-1-09500
Engineering Flow Study Submittal

Dear Sirs:

Pursuant to the Consent Decree issued to the City of Perth Amboy, New Jersey filed on September 28, 2012, we are herewith submitting the required Engineering Flow Study (Study) that details the required assessments of the City's Combined Sewer System.

The Study presents information regarding the following:

- Assessment of the capacity of the State Street Pumping Station wet well and related components;
- Assessment of the capacity of the Front Street Pumping Station wet well and related components;
- Assessment of interceptor flow velocities to determine if self-cleaning velocities are attained; and
- Assessment of the position of weir plates in diversion chambers

CDM Smith

In accordance with the terms of the Consent Decree, the City will look for EPA's approval of the enclosed prior to initiating any activities with regard to it.

Please feel free to contact me if you have any questions with regard to the enclosed Study.

Very truly yours,

Howard S. Matteson, P.E., BCEE
Senior Project Manager
CDM Smith Inc.

Cc: Mayor and Business Administrator
City of Perth Amboy
260 High Street
Perth Amboy, NJ 08861

Middlesex Water Co. – USA-PA
Luis Perez-Jimenez
260 High Street
Perth Amboy, NJ 08861

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Section 1

Section 1
Introduction

1.1 Background

The City of Perth Amboy's combined sewer system (CSS) consists of 16 combined sewer overflows (CSOs) and a 4.3-mile combined sewer interceptor. Each CSO is fitted with an outfall pipe to convey excess stormwater and sewage to either the Arthur Kill or Raritan River during wet weather periods. While the City of Perth Amboy retains ownership of the existing sewer infrastructure, Utility Service Affiliates-Perth Amboy, Inc. (USA-PA) acts as the contract operator of the City's sewer system. This Engineering Flow Study has been prepared in partial fulfillment of the Corrective Action Plan included as part of Consent Decree requirements that were issued to the City on September 28, 2012.

1.2 Report Summary

As required under the Corrective Action Plan, this report includes the following:

- Engineering Assessments of the State Street and Front Street Pumping Stations wet wells and related components;
- Assessment of the interceptor flow velocities to determine if self-cleaning velocities are attained.
- Assessment of the weir plates in diversion chambers

Recommendations and implementation schedule, as appropriate, have been included in Section 7.

Section 2

Section 2

State Street Pumping Station Existing Conditions

2.1 Introduction

The State Street Pumping Station (SSPS) is located under the Outerbridge Crossing at 800 State Street in Perth Amboy, New Jersey. Wastewater conveyed to this pumping station is pumped through an 18-inch force main to a manhole at the intersection of State Street and James Street, where it discharges to the gravity interceptor.

The facility consists of inlet screening, a rectangular wet well, a dry well, a control room, and a generator room.

An initial field investigation of the SSPS wet well was conducted on January 16, 2013, as well as subsequent field investigations in February 2013. Photos taken during these field investigations are included in Appendix A. Observations made during these field investigations serve as part of the basis for this assessment.

2.2 Inlet conditions

Wastewater is conveyed into the pump station via a 36-inch diameter inlet pipe, and flows through a manual bar screen. Flow is then directed into one of two 30-inch wide channels. A hydraulic channel grinder is located in a primary channel, and the other channel serves as the bypass channel. During our site visit, the channel grinder was not operational. Staff reports the existing channel grinder will be removed under a design for a new automated bar screen that is ongoing.

Both channels are moderately sloped with an average depth from the grating of approximately 60-inches. Figure 1 shows a schematic plan view of the inlet screening.

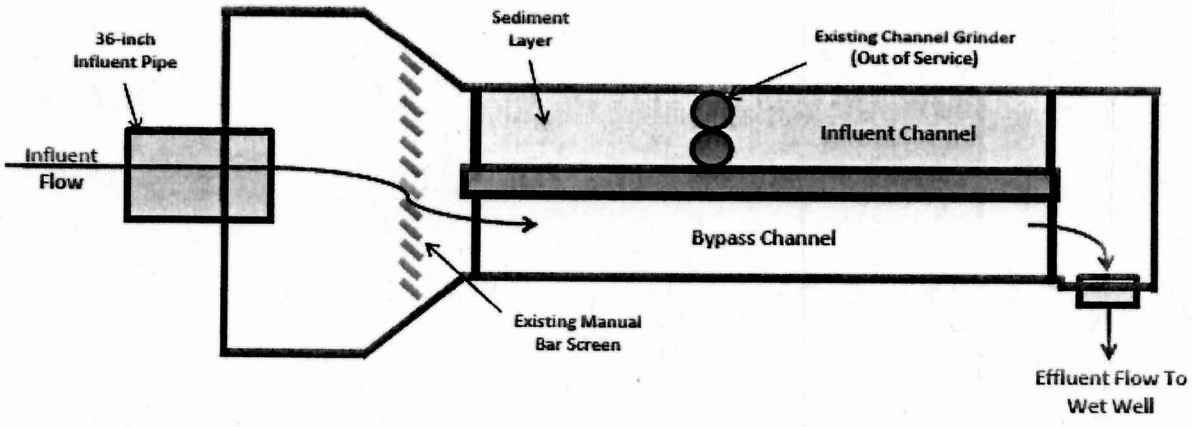

Figure 1 - Plan View Schematic of the State Street Pumping Station – Inlet Screening

With the existing channel grinder out of service, the current operating condition has all flow directed through the bypass channel. Some sediment was noted in the bypass channel during our inspection.

Wastewater is conveyed from the inlet screening area through an effluent channel to the wet well.

2.3 Wet Well

The SSPS is served by a reinforced concrete rectangular wet well. The wet well is 19 feet by 6 feet by 21 feet (length by width by height).

The base of the wet well is flat and there are no sloped transitions between the floor and walls.

CDM Smith performed probing of the wet well that indicated approximately 12-inches of sediment is concentrated in the corners and along the centerline of the wet well. Decreased levels of sediment were encountered near the suction pipes.

2.4 Pumping System

The State Street Pumping Station has two (2) Fairbanks Morse vertical flex shaft solids handling pumps. Both pumps are identical in their design and have historically operated as constant speed pumps. Staff reports the pumps are currently being converted to operate using Variable Frequency Drive controllers.

Pump and motor data for the SSPS are listed in Table 1.

Table 1 – State Street Pumping Station - Pump and Motor Data

Description	Value
Pump Capacity	3,200 GPM
Total Dynamic Head	66 feet
Horsepower	75
RPM	900
Phase/Cycle/Volts	3/60/460

Section 3

Section 3

Front Street Pumping Station Existing Conditions

3.1 Introduction

The Front Street Pumping Station (FSPS) is located at 256A Front Street next to the Perth Amboy Municipal Marina Building on the eastern shoreline of the City. Wastewater conveyed to this pumping station is pumped to a manhole on Water Street through a 16-inch force main, where it discharges to the gravity interceptor.

The facility consists of a reinforced concrete wet well, and an underground steel CAPSULAR® pumping station dry well and control room.

3.2 Inlet Conditions

Wastewater is conveyed to the pumping station via a 48-inch diameter inlet pipe, and flows through a manual bar screen and channel grinder. The grinder is mounted in the channel and the bar screen is located above the grinder to treat influent wastewater that passes over the grinder during high flow events.

Immediately following the channel grinder/manual bar screen, wastewater is discharged to the wet well.

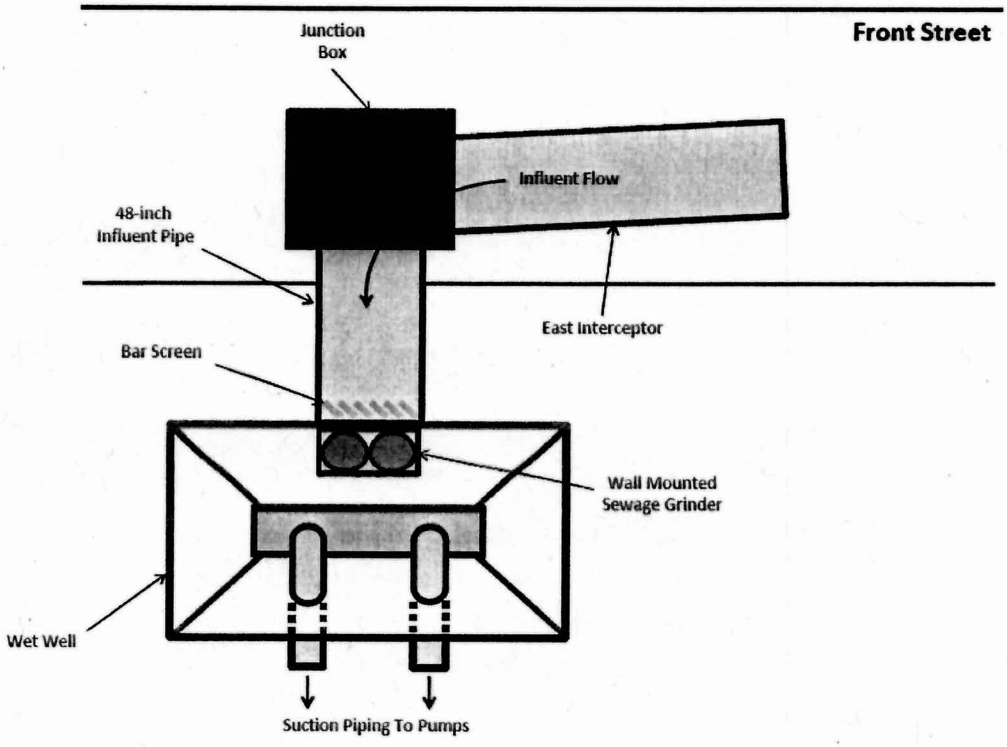

Figure 2 - Plan View Schematic of the Front Street Pumping Station – Inlet Screening

3.3 Wet Well

Note: CDM Smith could not gain access to the FSPS wet well, however we were able to probe the wetwell with a piece of PVC pipe. Dimensional information presented below was obtained from the construction drawings.

The FSPS is served by a wet well measuring 13.5 feet by 6 feet by 11.5 feet (length by width by height).

The perimeter of the wet well has 45-degree sloped sides to a height of approximately 24-inches. A 20-inch wide flat surface remains at the base of the wet well.

CDM Smith was able to perform limited probing of the wet well adjacent to the grinder and manual bar screen. No sediment was observed.

3.4 Pumping System

The FSPS is served by two (2) Smith and Loveless dry pit submersible pumps. Suction and discharge piping is 16-inch diameter ductile iron. Both pumps are identical in their design and operate using Variable Frequency Drive (VFD) controllers.

Pump and motor data for FSPS are listed in Table 2.

Table 2 – Front Street Pumping Station - Pump and Motor Data

Description	Value
Pump Capacity	4,870 GPM
Total Dynamic Head	60 feet
Horsepower	125
RPM	1200
Phase/Cycle/Volts	3/60/460

Section 4

Section 4

Engineering Assessment of Pumping Stations

This section addresses the Corrective Action Plan requirement regarding Engineering Assessments of the State Street and Front Street Pumping Station wet wells and related components.

The assessment of the State Street and Front Street Pumping Stations considers general criteria found in the Hydraulic Institute Standard ANSI/HI-9.8 (1998) (HI-9.8) Pump Intake Design under Section 9.8.3 - "Intake Structures for Solids Bearing Liquids".

The following section of the HI-9.8 were considered for this assessment:

- Section 9.8.3.1 – General – Considers special considerations to allow for the removal of floating and settled solids that include geometry and provisions to remove material that would otherwise be trapped and result in undesirable conditions.

As a general principal, HI-9.8 states that intake structures for solids-bearing liquids shall seek to minimize horizontal surfaces in the wet well anywhere but directly within the influence of the pump inlets, thereby directing all solids to a location where they may be removed by the pumping equipment. For intake structures that cannot fully minimize horizontal surfaces, such as rectangular wet wells, currents should be swift, and violent mixing should be maintained to suspend sediments while wastewater is being moved by the pumps. (HI-9.8.3.1.3)

4.1 HI-9.8 – Section 9.8.3.1 - General

4.1.1 Section 9.8.3.1.4 - Vertical Transitions

HI-9.8 Section 9.8.3.1.4 states that transitions between levels in wet wells for solids bearing liquids shall be at steep angles (60° minimum from horizontal for concrete, 45° minimum from horizontal for smooth surfaced materials and coated concrete) to prevent solids accumulation and to promote movement of material to a location within the influence of currents entering the pump intakes. Horizontal surfaces should be eliminated where possible except near the pump inlet.

4.1.1.1 State Street Pump Station

Visual inspections and physical probing of the State Street Pumping Station (SSPS) wet well indicated no vertical transitions other than vertical walls, which extend at 90-degree angles from the base of the wet well to the ceiling of the wet well. The entire base of the wet well, including the sections near the pump inlets, can be characterized as one uniform horizontal surface.

The flat geometry of the wet well does not preclude solids accumulation nor promote movement of material to a location within the influence of currents entering the pump intakes.

Therefore, the SSPS wet well does not meet HI-9.8 Section 9.8.3.1.4 regarding vertical transitions.

4.1.1.2 Front Street Pump Station

Contract drawings indicate that the Front Street Pumping Station (FSPS) wet well maintains 45° transitions between all levels in the wet well. These slopes were verified using a probing device during a site inspection of the FSPS. Contract drawings indicate the horizontal surfaces are minimized to a 20" wide surface at the base of the wet well, which promotes movement of the solids toward the suction inlets.

The base geometry of the FSPS wet well promotes suspension and movement of solids to a location within the influence of currents entering the pump intakes.

Therefore, the FSPS wet well meets HI-9.8 Section 9.8.3.1.4 regarding vertical transitions.

4.1.2 Section 9.8.3.1.5 - Confined Inlet

HI-9.8 Section 9.8.3.1.5 states that horizontal surfaces immediately in front (for formed suction inlets) or below (for bell inlets) should be limited to a small, confined space directly in front of or below the inlet itself. The walls of the inlet must be confined so that currents can sweep settleable solids to the inlet.

4.1.2.1 State Street Pump Station

Visual inspections and physical probing of the SSPS wet well indicated no confined inlets. As stated in the previous section, the entire base of the wet well, including the sections near the pump inlets, can be characterized as one uniform horizontal surface.

The inlet arrangement at the SSPS does not meet HI-9.8 Section 9.8.3.1.5. regarding Confined Inlet conditions.

4.1.2.2 Front Street Pump Station

A 20-inch wide horizontal surface is formed on the base of the FSPS wet well for the location of the suction inlet. The walls of the inlet zone are sloped at 45°. The confined inlet allows settleable solids to be swept downward to a location within the influence of currents entering the suction inlet.

The inlet arrangement at the FSPS meets HI-9.8 Section 9.8.3.1.5. regarding Confined Inlet conditions.

4.1.3 Section 9.8.3.1.7 – Wet well volume

HI-9.8 Section 9.8.3.1.7 indicates wet wells for variable speed pumping stations need not be designed for storage when they are designed to match outflow with inflow, but should be designed to accommodate inlets and geometry that promote cleaning.

4.1.3.1 State Street Pumping Station

The SSPS is currently served by variable frequency drive controllers.

Average dry weather inflow to this station has previously been reported to be 1.62 mgd, while the single pump pumping capacity is 4.61 mgd (3,200 gpm). If implemented fully, the Perth Amboy Redevelopment Plan would generate an estimated 0.30 mgd of flow to the State Street Pumping Station.

Pumping capacity exceeds average dry weather flow. Therefore, outflow exceeds inflow and the wet well needs not be designed for storage. Therefore, the results of this assessment are that the wet well has sufficient capacity.

4.1.3.2 Front Street Pump Station

The FSPS is currently served by variable frequency drive controllers.

Average dry weather flow to the station has previously been reported to be 2.41 mgd, while the single pump pumping capacity is 7.01 mgd (4,870 gpm). If implemented fully, the Perth Amboy Redevelopment Plan would generate an estimated 0.66 mgd of flow to the Front Street Pumping Station.

Pumping capacity exceeds average dry weather flow. Therefore, outflow exceeds inflow and the wet well needs not be designed for storage. Therefore, the results of this assessment are that the wet well has sufficient capacity.

Section 5

Section 5

Engineering Assessment of Interceptor Flow Velocities

This section addresses the Corrective Action Plan requirement regarding an engineering assessment of the interceptor flow velocities to determine if self-cleaning velocities are attained.

5.1 Introduction

Deposition of sediment and suspended material is of particular concern for sanitary sewer and combined sewers. Particles that reach the bottom of the conduit do not remain as permanent deposits if the velocity and turbulence are sufficient to resuspend them or move them along the bottom.[1] For the purposes of this assessment, the velocity sufficient to prevent deposits shall be considered self-cleaning velocity.

5.2 Assessment of Interceptor Flow Velocities

For the purposes of this assessment, interceptor flow velocities were evaluated as follows:

- Primary evaluation – through visual review of CCTV inspection of the City's interceptor performed in January 2013. In addition, where possible, this inspection included measurement of sediment level in the pipes. The primary evaluation also includes a review of the sediment levels measured as part of this CCTV inspection. Evidence of sediment in individual pipe segments was considered a direct measure that self-cleaning velocities were not attained (in that pipe segment). We were able to assess most pipes using this primary evaluation metric.

- Secondary evaluation – where sediment levels were not available, and depth of flow was appreciable, CDM Smith considered output of SWMM modeling of the CSS using as-built information and pumping capacities as noted in Section 2.4 and Section 3.4.

Based on approach described above, CDM Smith developed the following graphics showing the overall assessment of interceptor flow velocities by pipe segment.

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[1] *Gravity Sanitary Sewer Design and Construction*, American Society of Civil Engineers and Water Pollution Control Federation (now Water Environment Federation), ASCE, New York, NY and WPCF, Alexandria, VA, 1982, pp 105-107.


m 36
m36A
m 34
m 33
m 32
m 32E
m 32D
m 32C
m 32B
m 31
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m 27
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Aerial - 2007-2008 High Resolution Orthophotography
NJ Office of Information Technology (NJOIT),
office of Geographic Information Systems (OGIS)

Assessment of Interceptor - Self Cleaning Velocities
Lower East (m 33 2nd St PS)

Engineering Flow Study
City of Perth Amboy
Middlesex County, New Jersey

CDM Smith

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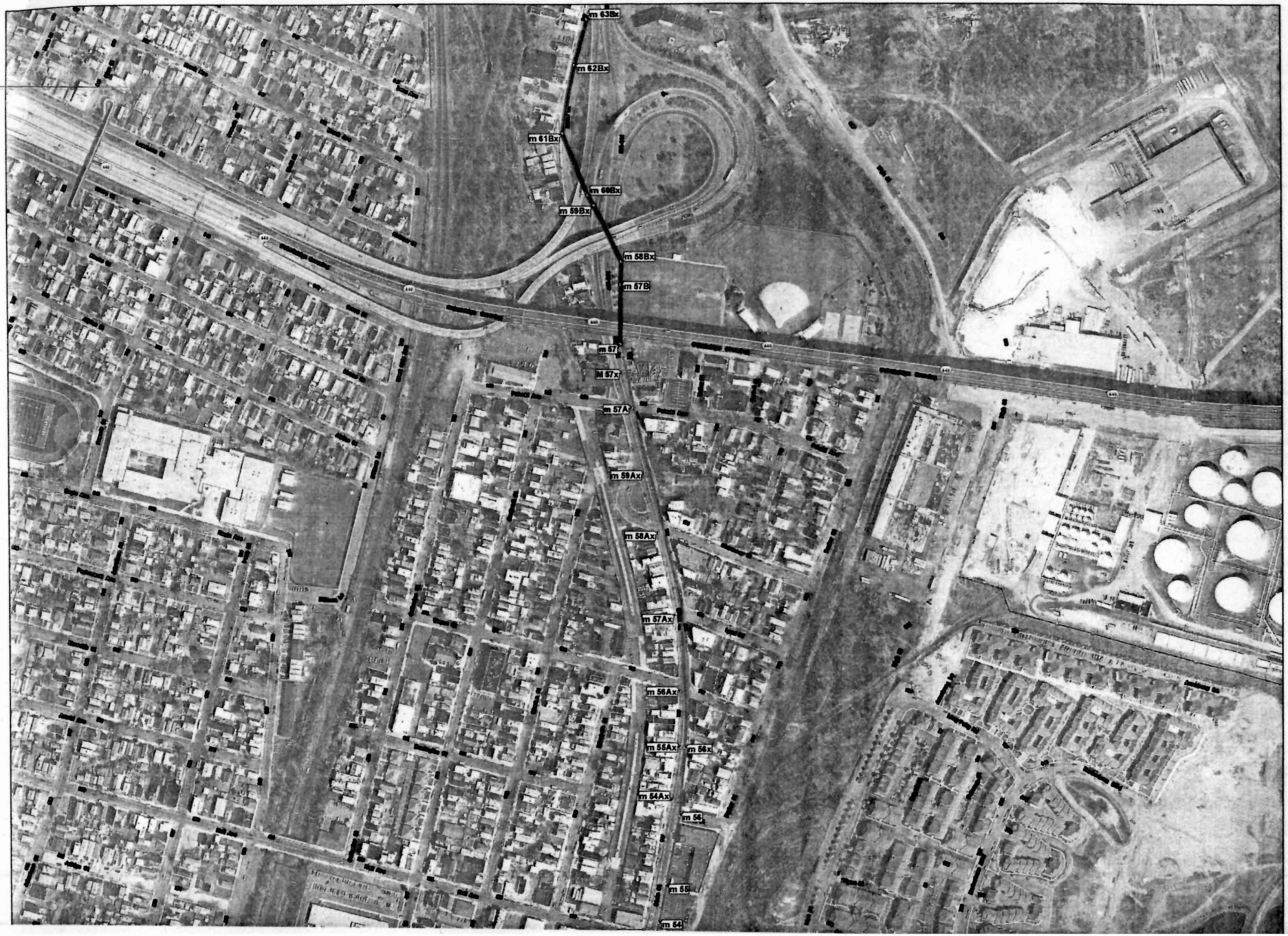
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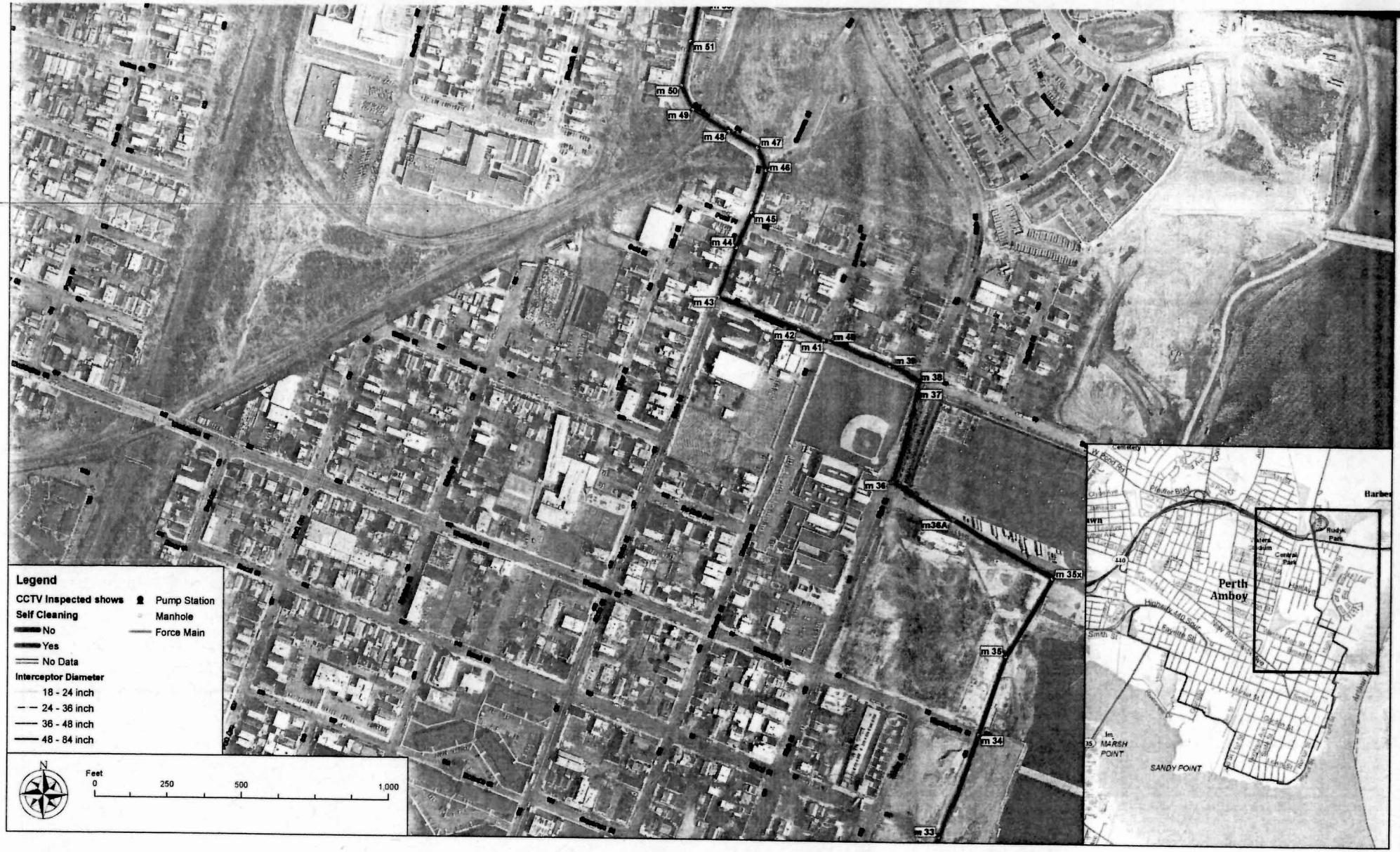

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Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Aerial - 2007-2008 High Resolution Orthophotography
NJ Office of Information Technology (NJOIT)
Office of Geographic Information Systems (OGIS)

Assessment of Interceptor - Self Cleaning Velocities
Upper East (m 63Bx - m 33)

Engineering Flow Study
City of Perth Amboy
Middlesex County, New Jersey

CDM Smith

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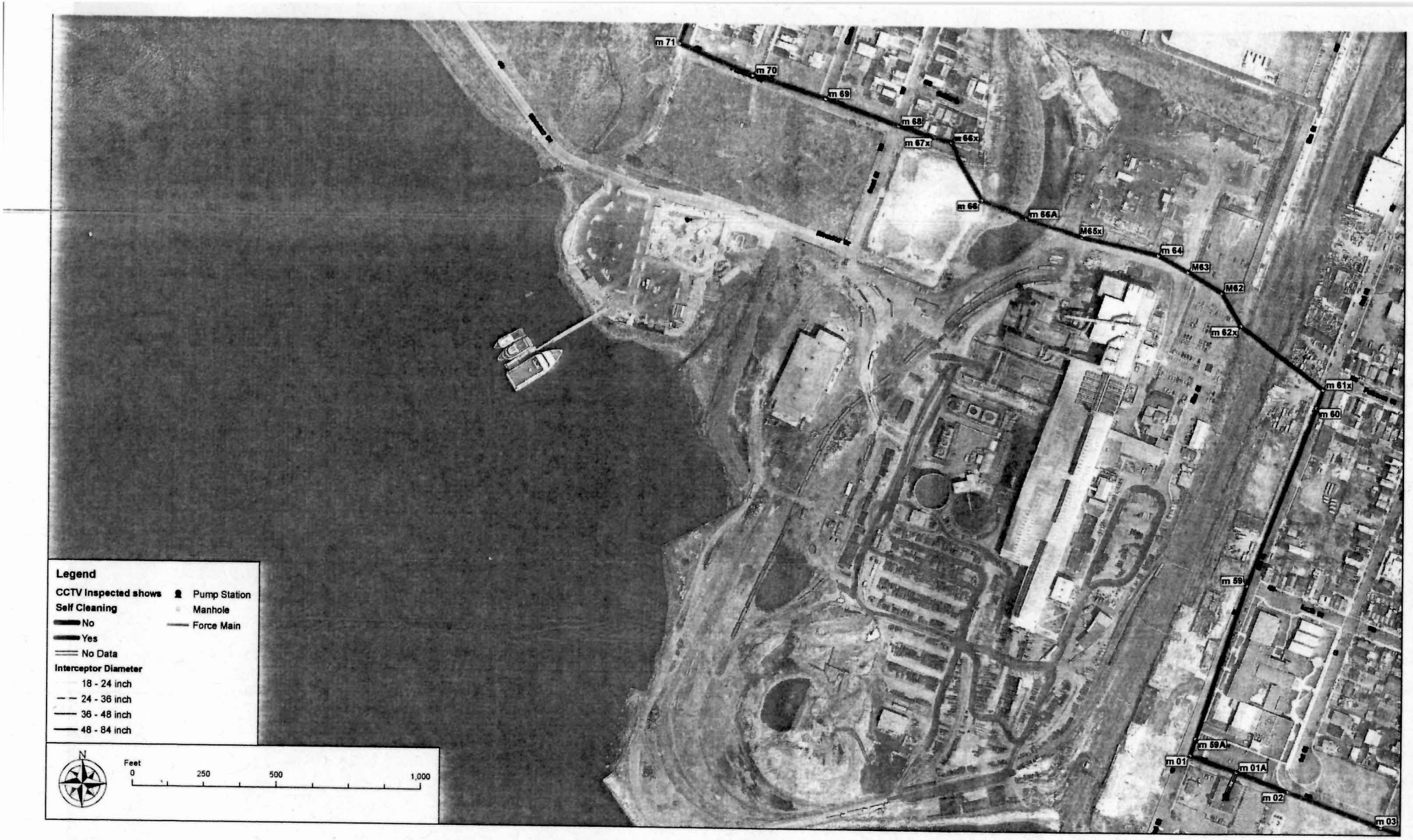

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Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community

Aerial - 2007-2008 High Resolution Orthophotography
NJ Office of Information Technology (NJOIT),
Office of Geographic Information Systems (OGIS)

CDM Smith

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Assessment of Interceptor - Self Cleaning Velocities West (m 100x to 2nd St PS)

Engineering Flow Study
City of Perth Amboy
Middlesex County, New Jersey

Section 6

Section 6

Assessment of Position of Weir Plates in Diversion Chambers

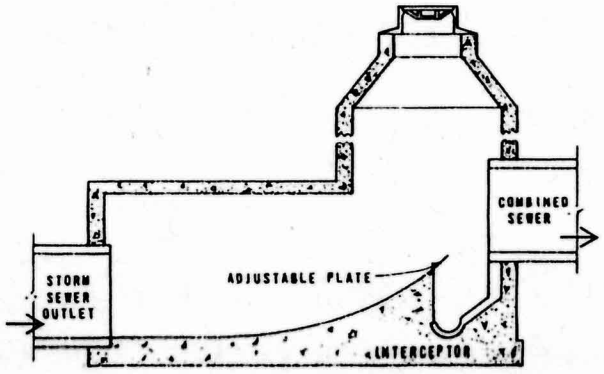
This section addresses the Corrective Action Plan requirement regarding an engineering assessment of the position of the weir plates in diversion chambers.

6.1 Introduction

There are a total of 16 diversion chambers in the City's combined sewer system. A number of these diversion chambers incorporate regulators designed for flow diversion (or "leaping weirs").

The leaping weir is a regulator that consists of an invert opening in the combined sewer dimensioned to permit dry weather flow to fall through the opening and to be conveyed through an interceptor to the main treatment plant (or in this case, the Main Pumping Station located on Second Street). During wet weather periods the increase in velocity and depth in the combined sewer causes the flow to pass over (or "leap over") the opening and be discharged out the CSO discharge pipe.

The description above is shown graphically in the cross-section of a regulator structure shown in Figure 3 below. Note: this structure is located in Seattle, Washington.[2]



(c) ADJUSTABLE LEAPING WEIR AT SEATTLE, WASH.

Figure 3 - Example of a Leaping Weir

[2] Moffa, Peter E., "Control and Treatment of Combined Sewer Overflows", Van Nostrand Reinhold, New York, NY, 1990, pp. 5-7.

Examples of leaping weirs serving the City of Perth Amboy CSS area shown in the pictures below.

Figure 4 - Gordon Street - CSO 008

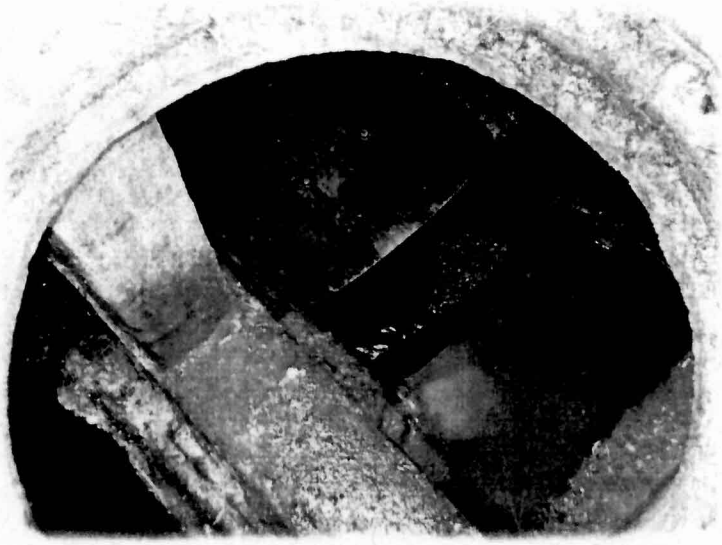


Figure 5 - Madison Ave - CSO 014

Staff reports, some of the weir plates in the City of Perth Amboy's Combined Sewer System (CSS) are adjustable. For those that are similar to that shown in Figures 4 and 5, the weir plates can be slide back to allow a larger opening for water to flow into the interceptor.

6.2 Assessment of Position of Weir Plates

Any adjustments to the weir plates should be considered in light of the potential to allow more CSS flow into the interceptor, and reduce the quantity permitted to overflow and be discharged through the CSO.

The basic principle of the leaping weir is that velocity is required to leap over the invert opening of the CSO pipe. This presumes the interceptor pipe is not full, nor has it surcharged above the top of the interceptor pipe/invert of the CSO pipe. If the interceptor surcharges beyond that point, the leaping weir ceases to function as a hydraulic device. So, it should be recognized that if the interceptor surcharges, the location of the weir plates will be irrelevant.

It is possible to adjust certain weir plates to allow more flow into the interceptor under typical wet weather conditions. The locations chosen should be selected based on where surcharge in the interceptor is least frequent. Based on SWMM model output of the City's CSS, we have developed the following table. Leaping weirs indicated least likely subject to interceptor surcharge should be adjusted first.

Table 3 - Leaping Weir Adjustment Table

Status	Description
Least Likely Subject to Interceptor Surcharge	CSO-005 (Commerce St.)
	CSO-007 (Smith St.)
	CSO-008 (near Front St. and Gordon St.)
	CSO-009 (Lewis St.)
	CSO-010 (High St.)
	CSO-017 (near Sheridan St. and Gordon St.)
Most Likely Subject to Interceptor Surcharge	CSO-011 (State St.)
	CSO-015 (First St.)
	CSO-013 (Brighton Ave)
	CSO-019 (Outer Smith St.)
	CSO-004 (Washington St.)
	CSO-006 (Fayette St.)
	CSO-014 (Madison Ave)
	CSO-003 (Buckingham Ave)
	CSO-002 (Rudyk Park)
	CSO-016 (Second St.)

Due to the complex hydraulic nature of the City's CSS, it will be important to adjust each weir plate incrementally over a sufficiently long period of time to evaluate any potential adverse impacts after every incremental change.

Likewise, it will be important for the City to maximize the conveyance capacity of the interceptor and pumping stations prior to the initiation of the weir adjustment program to minimize the chance of inadvertent surcharge in the interceptor due to the additional amount of flow being conveyed in it.

Section 7

Section 7

Recommendations and Schedule

This section addresses the Corrective Action Plan requirement regarding recommendations, as appropriate, and a schedule.

7.1 Recommendations

7.1.1 State Street Pumping Station

The wet well of the State Street Pumping Station does not comply with the requirements of HI-9.8. To address this, the City should:

- Modify the wet well to comply with the guidance provided in HI-9.8 or
- Institute a periodic cleaning program to resuspend the sediment in the wet well and pump it out, or remove the sediment entirely.

7.1.2 Interceptor Cleaning

The City should develop a cleaning program that targets the pipes identified in Section 5 that do not appear to achieve self-cleaning velocities.

Periodic inspection of these pipes is further recommended to determine if additional cleaning is required.

7.1.3 Adjustment of Weir Plates

Once the conveyance capacity of the system has been maximized, and all sewer cleaning is complete, the City should critically evaluate which weir plates can be adjusted, and begin to incrementally open individual weir plates beyond their current location.

Table 3 in Section 6.2 should serve as the basis for choosing which weir plates to adjust initially.

7.2 Schedule

7.2.1 State Street Pumping Station

We anticipate the proposed modifications to the State Street Wet Well can be accomplished within one (1) year following completion of the Interceptor Cleaning, pending budgetary approval by the City.

A periodic cleaning program for the State Street Wet Well can likely be implemented as funds permit.

7.2.2 Interceptor Cleaning

The interceptor cleaning is the most important recommendation and should be prioritized over the others. It should be accomplished as soon as possible, pending budgetary approval by the City.

Table 3 in Section 6.2 should serve as the basis for choosing which weir plates to adjust initially.

7.2.3 Adjustment of Weir Plates

Once the Interceptor Cleaning is complete, adjustment of the weir plates can commence. We anticipate that at least two (2) wet weather seasons will be necessary to meaningfully adjust the weir plates and properly assess system response.

We recommend re-evaluating the weir adjustment program following this initial phase period with consideration given to the then current observed conditions in the system during wet weather events.

Appendix A

Appendix A

Photo Description: Top operating floor; view from northwest end

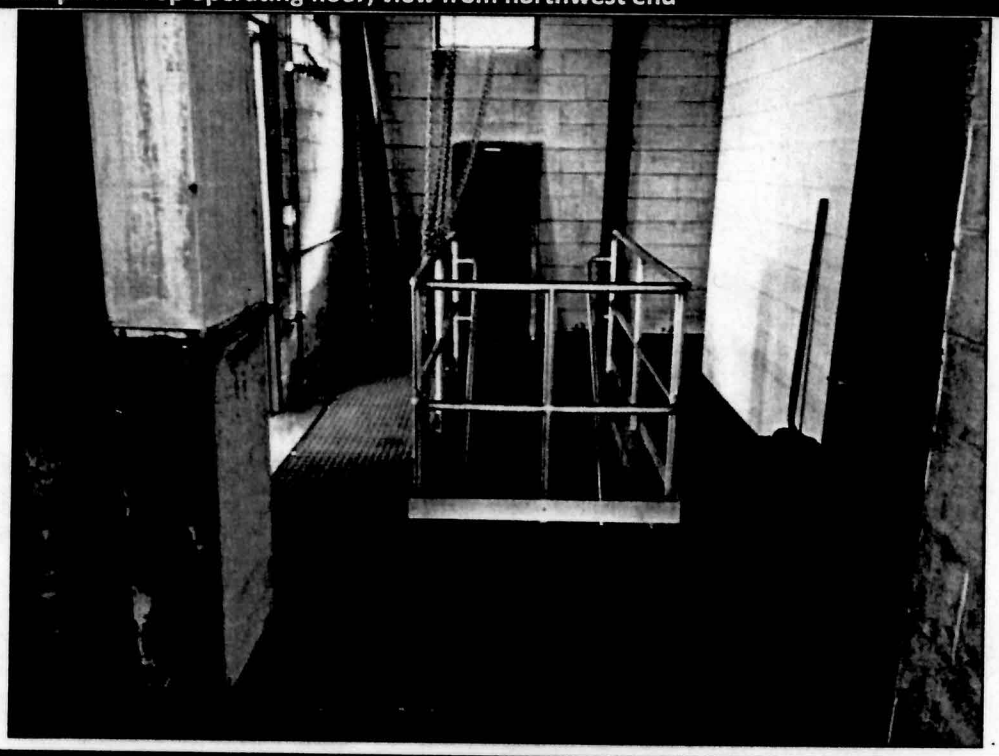


Photo Description: Top operating floor; view from southeast end

Photo Description: Bottom operating floor; view from the stairs

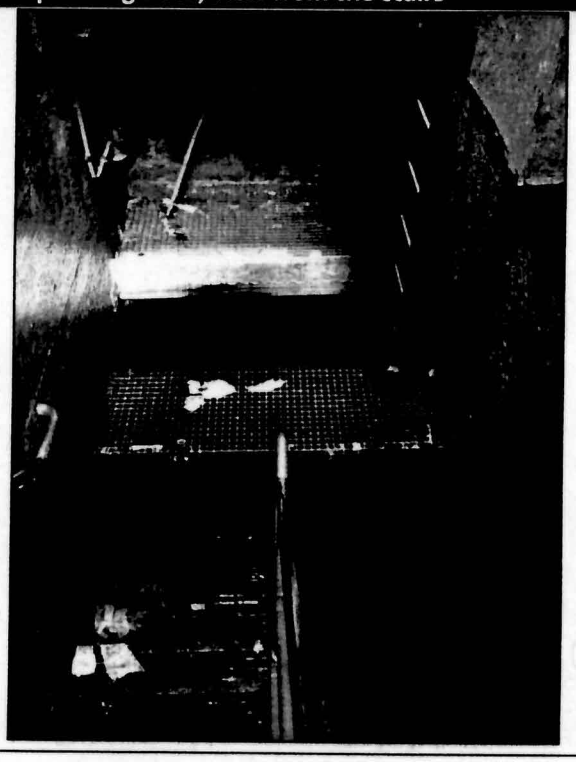


Photo Description: Bottom of the stairs; location for manual slide gates

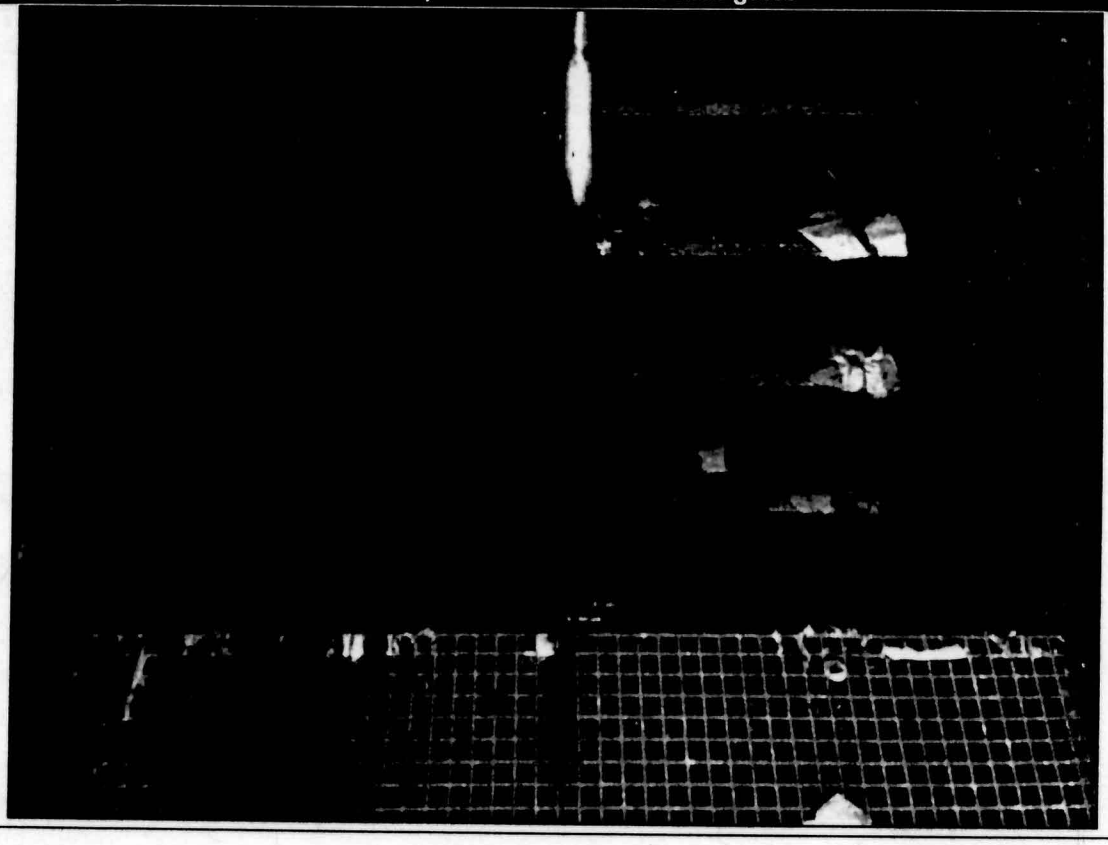


Photo Description: Influent Pipe and existing manual bar screen

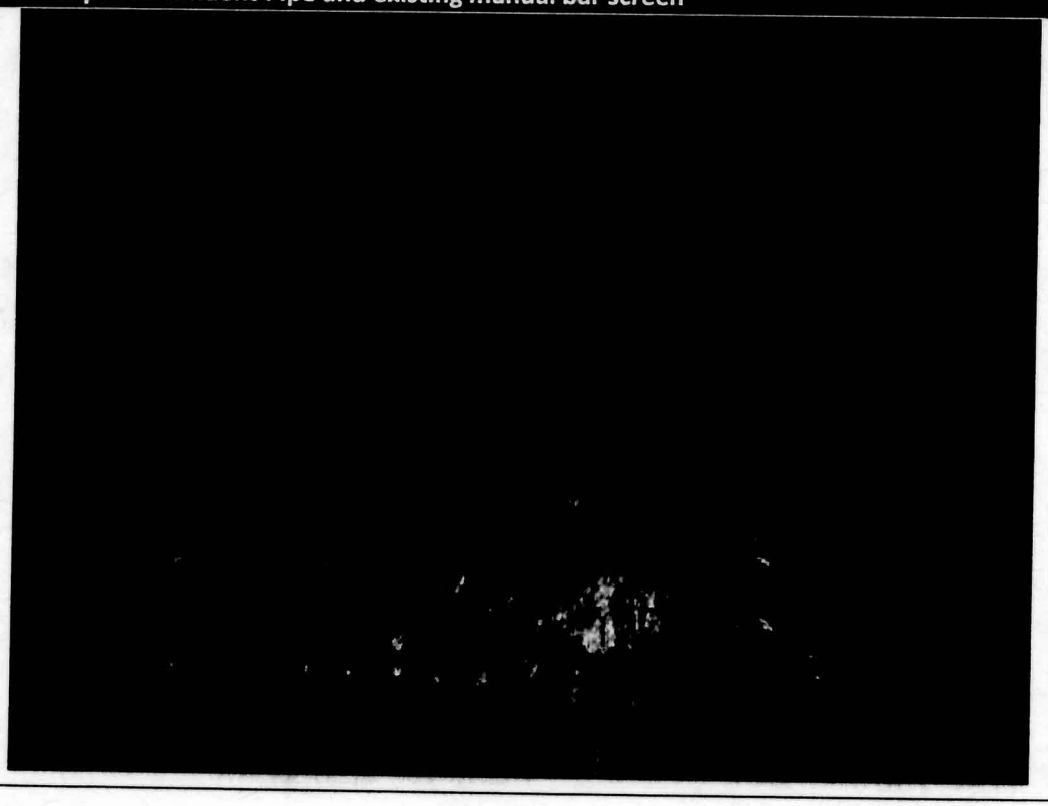


Photo Description: State Street Pumping Station Wet Well

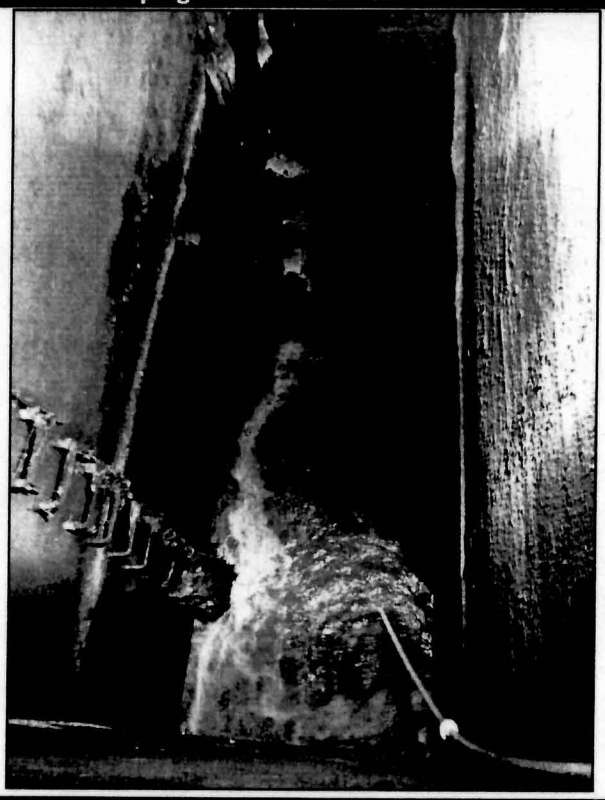


Photo Description: Discharge Piping

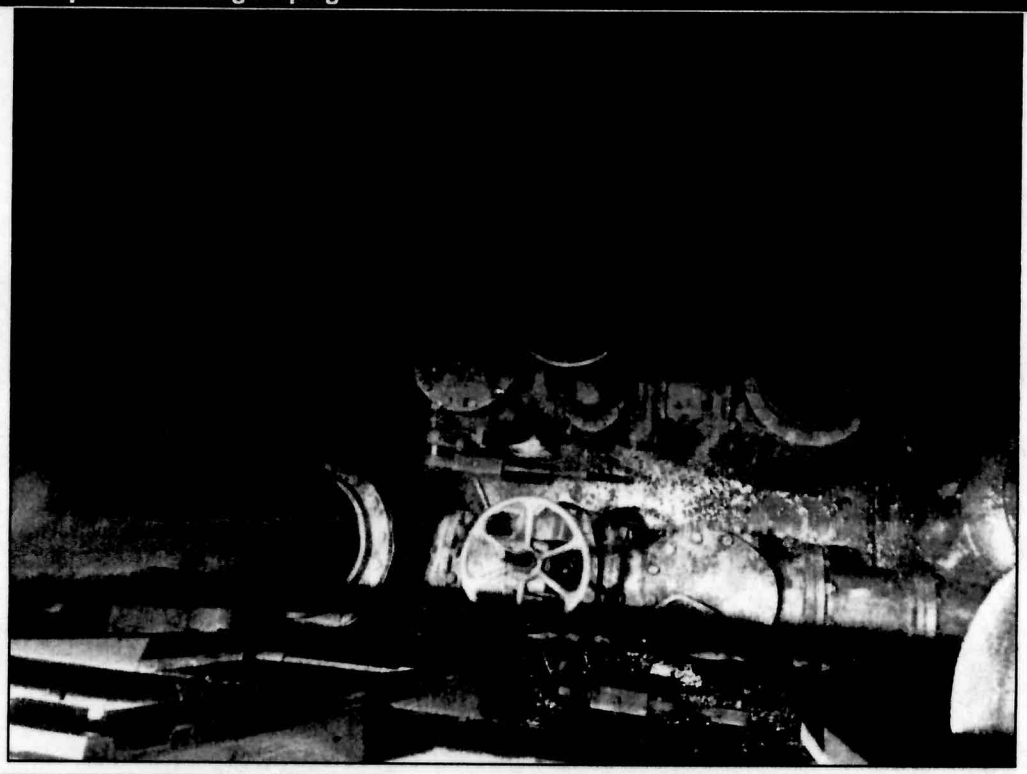


Photo Description: Discharge piping and Fairbanks Morse pumps

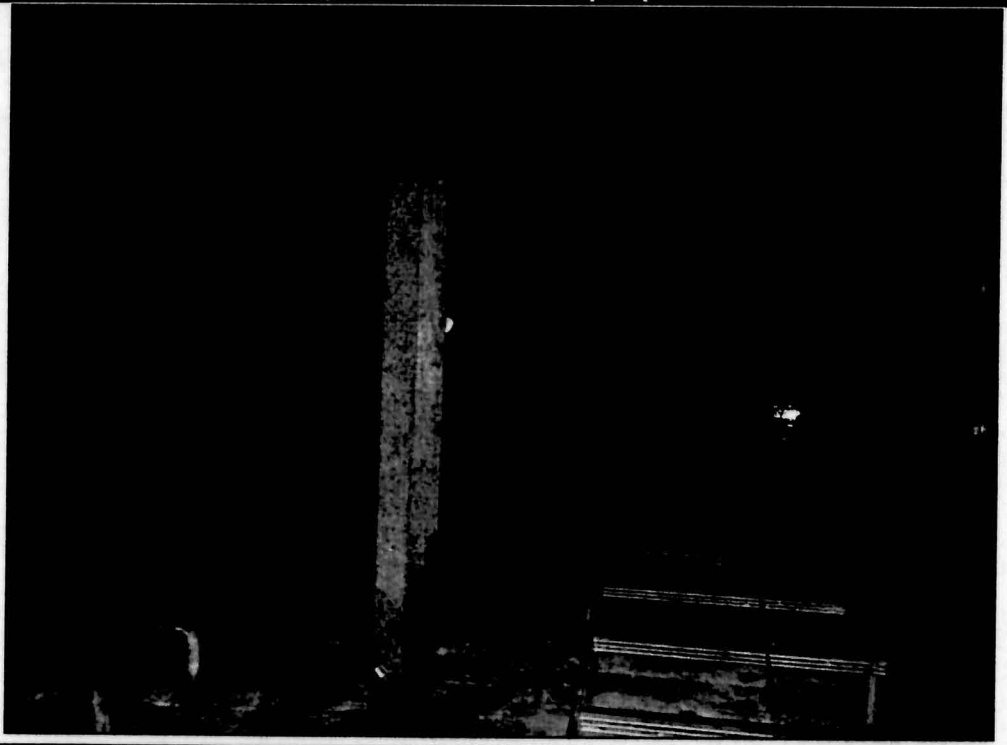


Photo Description: Discharge piping and Fairbanks Morse pumps

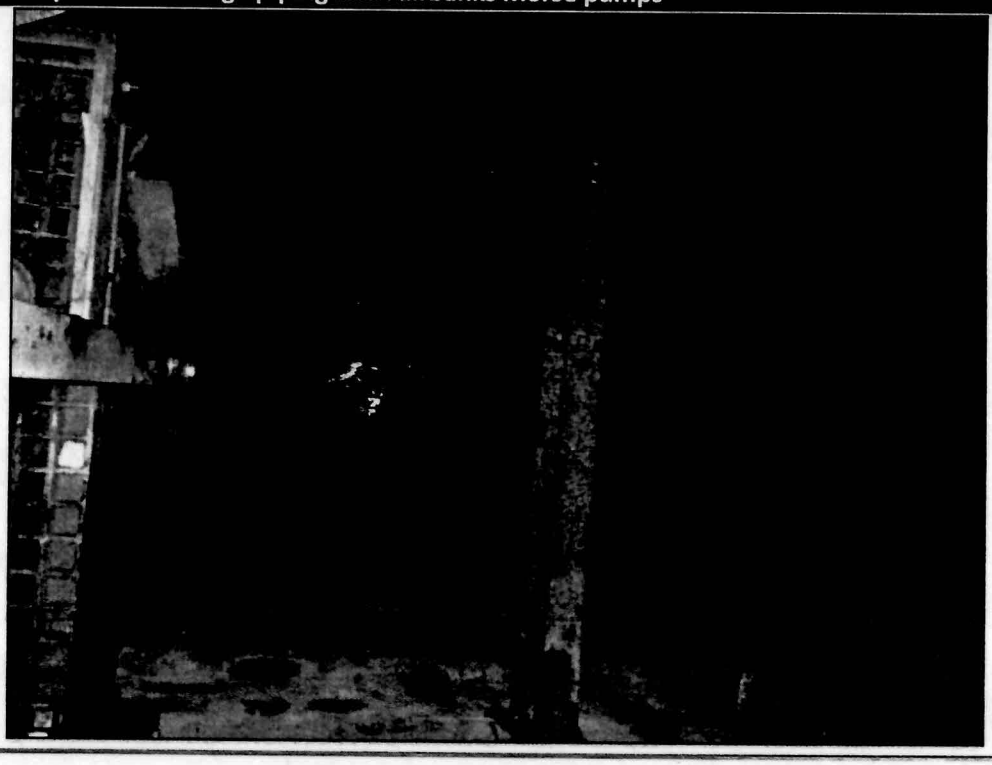


Photo Description: Street level approach from Front Street to the pumping station

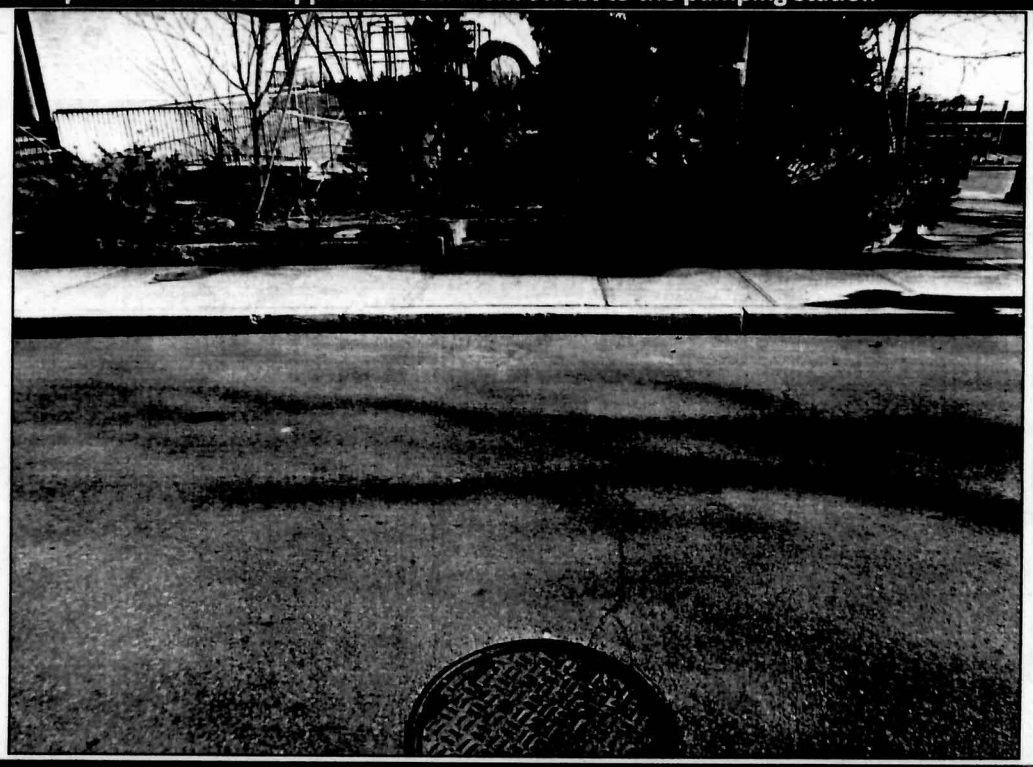


Photo Description: Access vault for in-channel grinder and bar screen

Photo Description: Top-down view of bar screen through access hatch

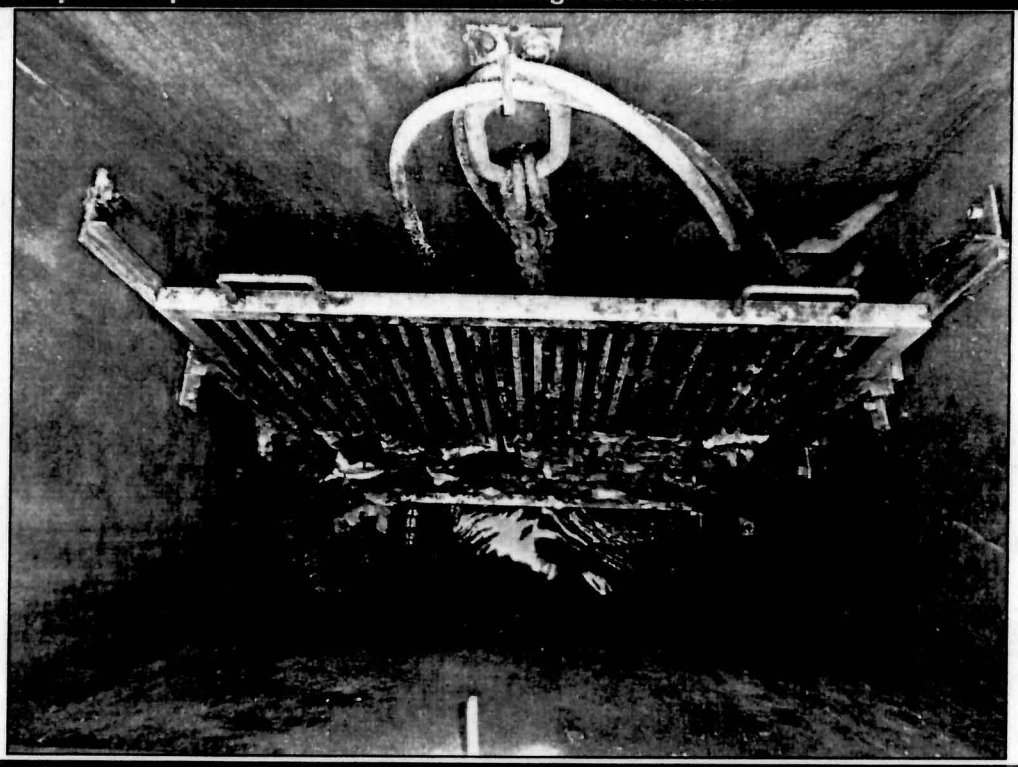


Photo Description: Top-down view of in-channel grinder through access hatch

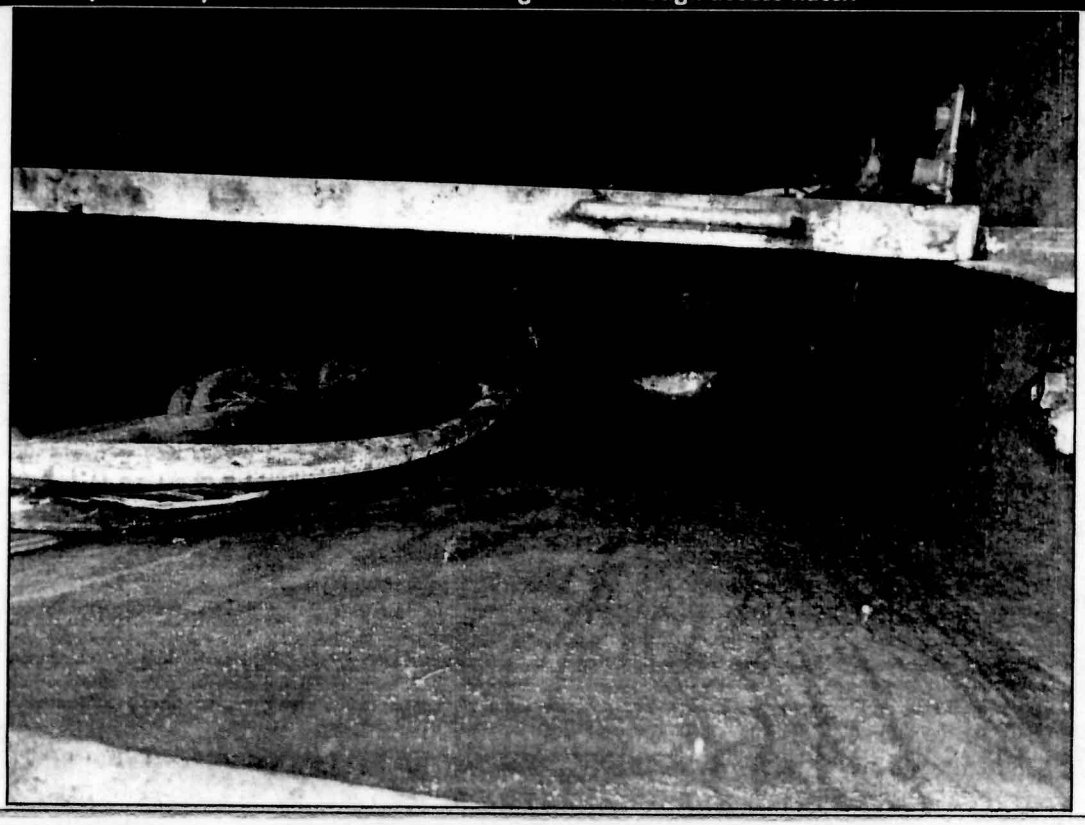


Photo Description: Platform for entrance tube to dry well

Photo Description: access ladder in entrance tube

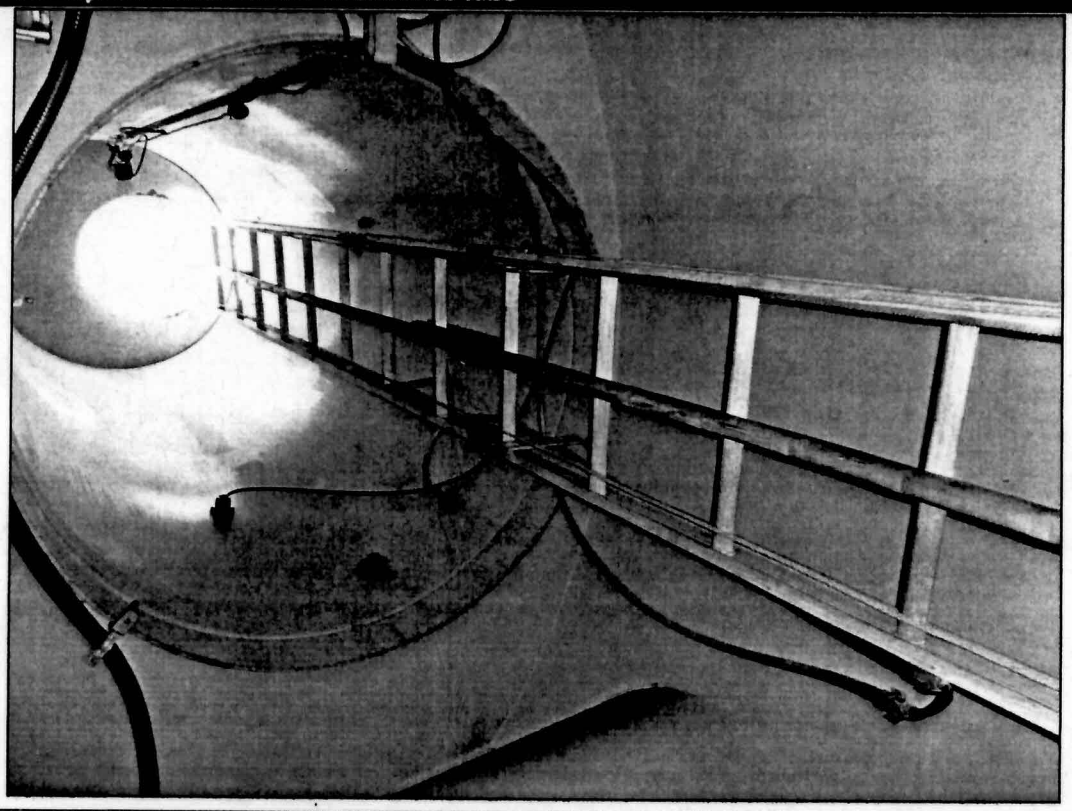


Photo Description: Smith and Loveless Monoshaft pump and motor assemblies

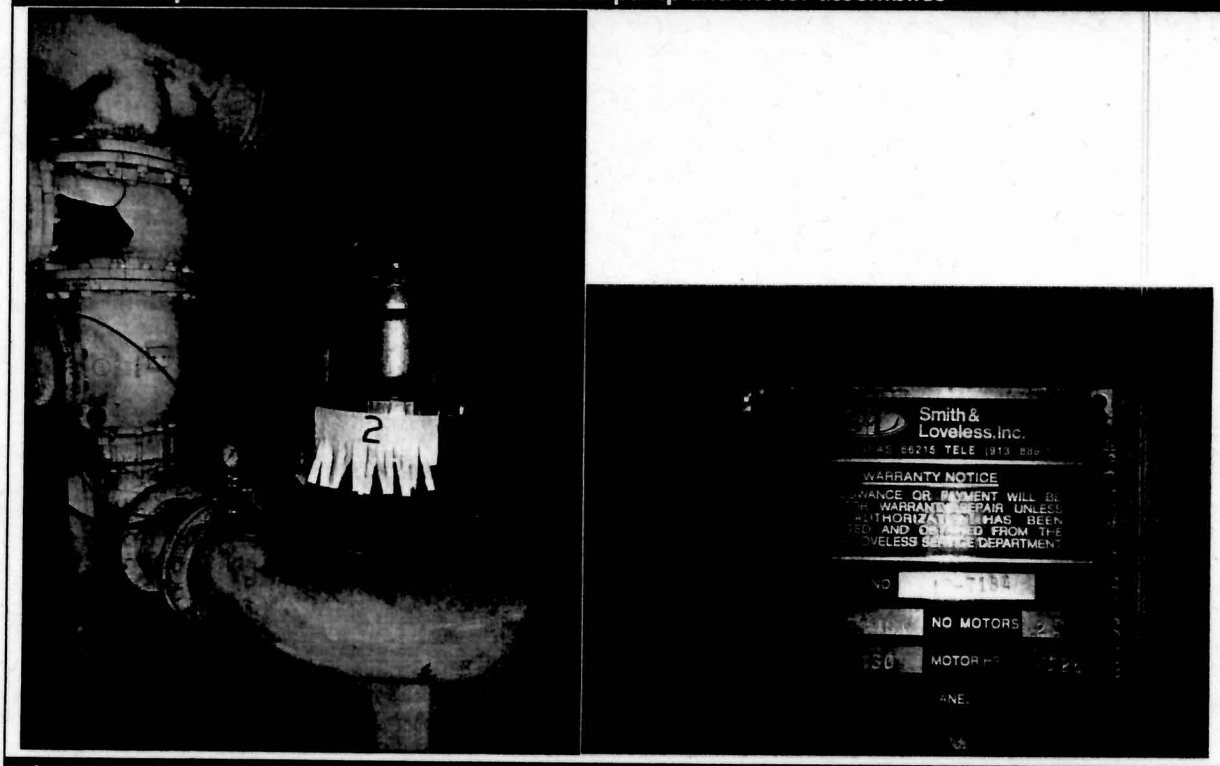


Photo Description: VFD Cabinet

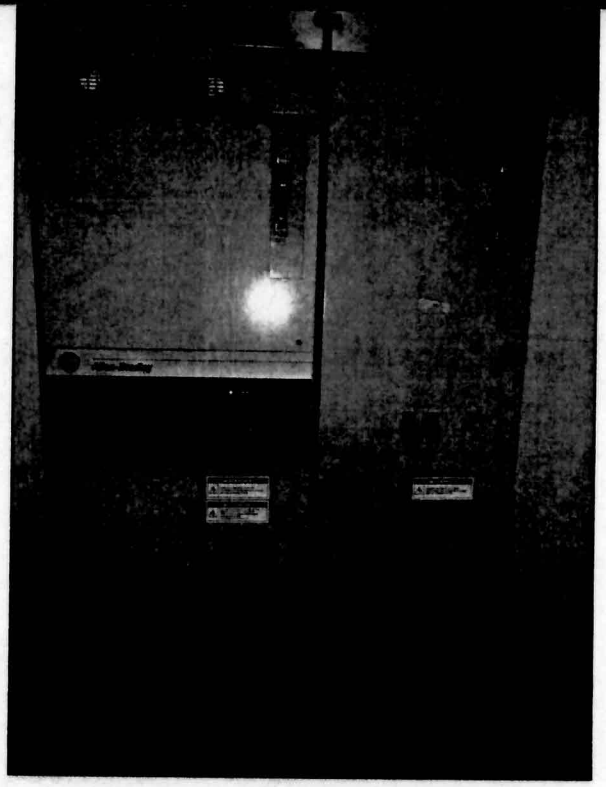
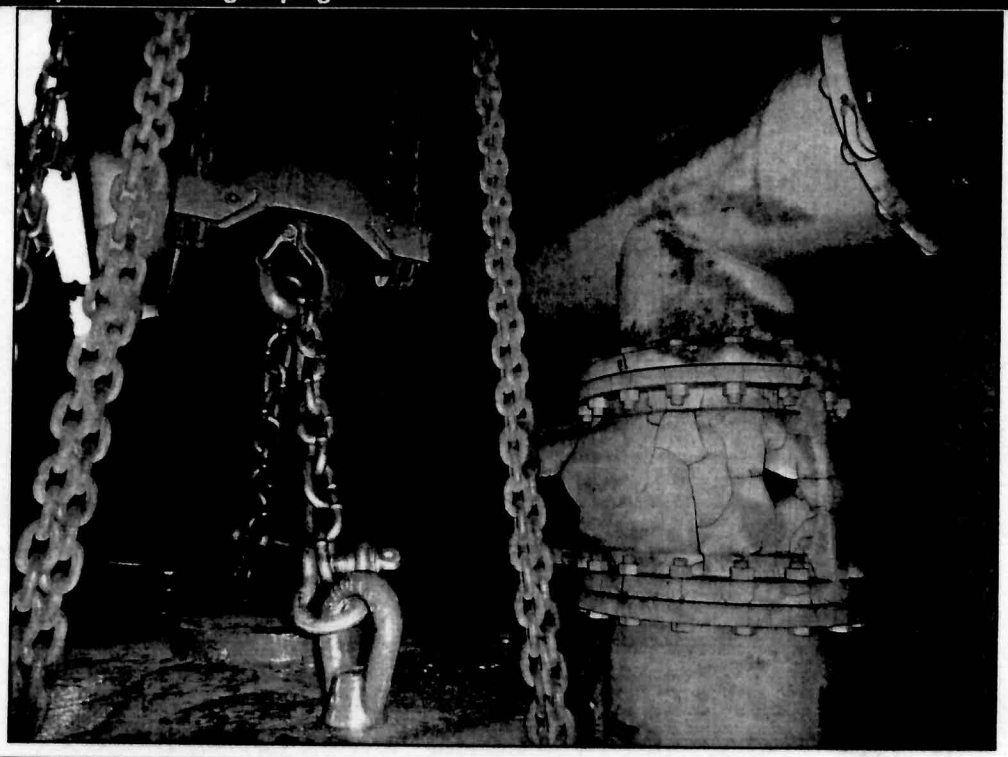


Photo Description: Discharge Piping



CDM Smith

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